
Contents

Introduction	xi
Part 1. Anthropocene Crisis and Ecological Transition	1
Introduction to Part 1	3
Chapter 1. Emergence of the Anthropocene: A History of the Dynamics of the Environmental Effects of Human Activity and Technology	5
1.1. In the beginning, humanity integrated into the biosphere	5
1.2. The first period of artificial human activity: from the Neolithic to the Industrial Revolution	6
1.2.1. The Neolithic revolution.	6
1.2.2. 5,000 years of slow human expansion.	9
1.3. The Industrial Revolution of the 18th century, the start of the Anthropocene	11
1.4. The peak of the Anthropocene.	12
1.4.1. The Second Industrial Revolution amplified the ecological crisis.	12
1.4.2. The peak of the contemporary technological system and the ecological crisis	17
Chapter 2. From the Ecological Crisis of the Anthropocene to the Ecological Transition	21
2.1. Structure and forms of the ecological crisis	22
2.1.1. Global warming/climate change	22
2.1.2. From atmospheric system disruption to hydrological system crisis.	22

2.1.3. Deregulation and degradation of the ecological system, leading to the extinction of animal species...	24
2.2. Anthropogenic factors: discarding, extraction and degradation	26
2.2.1. Greenhouse gas emissions.	26
2.2.2. “Contaminating the world”: chemical and biological pollution.	29
2.2.3. Waste production	31
2.2.4. Resource depletion	33
2.2.5. The degradation of natural areas and the artificialization of space	37
2.3. A process marked by a sense of urgency	38
2.4. From crisis to ecological transition: the imperative of technological change	39
2.4.1. The ecological crisis is forcing us to take into account the environmental impact of the technologies used in our activities	39
2.4.2. The need to eliminate technologies with destructive effects, the “euthanasia of technologies”	41
2.4.3. Generating incremental technological innovations to improve the ecological efficiency of traditional non-replaceable technologies.	41
2.4.4. Generating a stream of new disruptive or resurgent technologies that are compatible with the environment	42
2.4.5. Unit level and global impact, the need for a diverse technological response.	43
2.4.6. Generating technologies to repair the damage caused by the ecological crisis, and overcome the bottlenecks of massive and rapid technological change	43
2.5. Technical note on modeling the ecological limit of a technology	44
2.5.1. Ecological limits of an activity	45
2.5.2. From contribution measurement to the unit indicator of ecological nuisance, the relevant technological framework	46
Part 2. Technological Change in the Face of the Ecological Crisis	47
Introduction to Part 2.	49
Chapter 3. Technological Change for the Energy and Transport Transition	51
3.1. Energy transition scenarios.	51

3.1.1. The planned phasing-out of fossil fuel thermal energy technologies	53
3.1.2. Two conventional thermal power generation methods in use	56
3.1.3. Use of renewable energies.	59
3.1.4. Concentrated solar power	60
3.2. Eco-technological changes in transport	67
3.2.1. Road transport.	68
3.2.2. Air transport	75
3.2.3. Maritime transport	79
3.2.4. Rail transport	82
Chapter 4. Technological Responses to the Ecological Crisis in Processing Activities	85
4.1. Mining.	85
4.1.1. Pollution and ecological degradation caused by the mining industry	85
4.1.2. Corrective technologies	87
4.2. Materials and primary processing industries	88
4.2.1. The steel industry.	88
4.2.2. Cement and building materials	88
4.3. The chemical industry	89
4.3.1. The chemical industry and the environment	89
4.3.2. Trends in the chemical industry's technological shift towards ecological transition	91
4.4. Ecological crisis and technological responses in the processing industries	93
4.4.1. The textile industry.	93
4.4.2. The leather industry	94
4.4.3. The food-processing industry.	95
4.4.4. Packaging	97
4.5. Electronics and the digital industry.	98
4.5.1. Information technologies perceived as immaterial and as reducing the ecological impact of other activities	98
4.5.2. Information technology worsens the ecological footprint	100
4.5.3. A self-growing system.	104
4.5.4. Possible responses	106
4.6. Housing and construction, the ecological impact of housing and its technological response	108
4.6.1. The ecological consequences of construction activities	108
4.6.2. The ecological effect of habitat structure and land use	108

4.6.3. Optimized architectural and urban design adaptation to climatic conditions	109
4.6.4. From “thermal sieves” to building insulation, which should lead to a powerful reduction in energy consumption	109
4.7. Agriculture, livestock and fisheries	110
4.7.1. Agriculture in the Anthropocene	111
4.7.2. Eco-technological solutions	113
4.7.3. Cellular agriculture	115
Chapter 5. Emerging Technologies: Repairing the Effects of the Ecological Crisis	119
5.1. Circular economy: recycling and reconditioning	120
5.1.1. Reuse and repurposing	120
5.1.2. Recycling	121
5.1.3. Product and system reconditioning	126
5.1.4. The local circular economy: industrial and territorial ecology	128
5.2. A decarbonization process, CO ₂ storage and recovery	129
5.2.1. CO ₂ storage	129
5.2.2. CO ₂ recovery	131
5.3. Artificial freshwater production	133
5.3.1. Two processes dominate desalination technology	133
5.4. Technologies for repairing environmental degradation: engineering and ecological engineering	135
5.4.1. Restorative ecological engineering technologies	136
5.4.2. Geo-engineering	137
Part 3. Technological Change for the Ecological Transition: Its Process and Limits	141
Introduction to Part 3	143
Chapter 6. Towards a New Technological System	145
6.1. “Creative destruction”: the first phase of technological change brought about by the ecological transition	145
6.2. Structure and forms of a new technological system	148
6.2.1. New generic technologies driven by ecological requirements	149
6.2.2. Traditional generic technologies reoriented by the ecological transition	154
6.2.3. Functional technologies specific to the ecological transition	157
6.3. The paths of eco-technological transition	159

6.3.1. The technological system is reorganized according to a new logic	159
6.3.2. Routes to eco-technological change	159
Chapter 7. Transition Procedures and Limits	165
7.1. The techno-ecological transition process	166
7.1.1. The drivers of change	166
7.1.2. Barriers to change	169
7.2. Limits to the effectiveness of technological change for the ecological transition	174
7.2.1. The mass effect in the ecological crisis	174
7.2.2. The reconfiguration of the technical-economic system induced by the initial technological change (towards a logic of sobriety and reduced growth)	177
7.3. Prospective assessment of the relative contribution of technological change and societal change to the ecological transition, using two forecasts of different ecological transition structures for France	182
7.3.1. Lessons from an environmental transition plan: “the shift project”.	183
7.3.2. Prospective modeling of four ecological transition paths, based on the case of France – Prospective Transitions 2050	186
Conclusion and Outlook	191
References	195
Index	203